

Equating speech with language is a fallacy, declare these authors. They describe a "plastic word" non-speech response approach that "opens a whole new vista for teaching the language-deficient child" to communicate.

# communication deficiencies from chimp to child

by John H. Hollis and John K. Carrier Jr.



Dr. Hollis is an associate professor of Administration and Foundations at Kansas State University, concentrating in Special Education. A *cum laude* graduate of the University of Wichita, he holds an M.S. degree from Kansas State College, Pittsburg. He received his doctorate with honors (Child Development major) from the University of Kansas in 1968. Mental retardation, developmental psychobiology, and animal behavior are his current fields of interest, and he is writing a book to be entitled *Prosthesis of Exceptional Behavior*.

Programmed learning, communication, and mental retardation are the three fields currently of most interest to Dr. Carrier. At the University of Kansas, he is both a research associate in the Bureau of Child Research and an adjunct assistant professor in the Speech Department. Dr. Carrier holds a B.A. (Speech major) from Denison University and an M.S. and Ph.D. (both majors, Speech Pathology and Audiology) from the University of Pittsburgh. His monograph, *Application of Functional Analysis and a Non-Speech Response Mode to Teaching Language*, to be published by the American Speech and Hearing Association, is in press.

## PROSTHESES FOR COMMUNICATION<sup>1</sup>

It has long been recognized that communication deficiencies are a salient characteristic of many handicapped children. For example, assessments of speech and language behavior of mentally retarded individuals reveal significant deficiencies in communication skills, e.g., vocabulary, sentence structure, conceptual and abstract language skills, voice quality, and articulation of speech sounds.<sup>2</sup> These behaviors may be only slightly below norms or may appear to be totally absent, but in any case the language and speech behavior is observed to be deficient in normal human environments.<sup>3</sup> It could be argued, however, that although these children lack speech and language, they are not retarded or deficient with respect to communication *per se*. Rather, many do communicate by other means such as gestures, scent-marking, and role playing (non-verbal behavior that functions in a communicative fashion).

The problems in teaching children with speech and language deficiencies may, in some ways, parallel the problems encountered by researchers who have attempted to teach chimpanzees to use a human communication system. They have learned essentially that spoken language, as used by humans, is not feasible in an organism lacking certain cognitive or physiological abilities, but they have also learned that certain types of prostheses, adapted to the organism, made some parameters of communication quite possible.

### Environmental Prosthesis: Acculturation mode

Four decades have passed since Kellogg<sup>4</sup> in 1931 discussed humanizing the ape. He was aware of the discovery of "wild" children, those who had been reared in feral environments, i.e., with little or no human contact. There are a number of reasonably well documented accounts of these children, e.g., "Itard's wild boy,"<sup>5</sup> Tredgold's 1915 description of Kasper Hauser,<sup>6</sup> and Squires' 1927 report about the "wolf children" of India.<sup>7</sup> These children were reported to have displayed behavior that would be considered adaptive with respect to survival in a feral environment. However, they lacked language and were, in general, significantly retarded with respect to the acquisition of behavior deemed acceptable by organized society. Kellogg<sup>8</sup> hypothesized that these children had progressed too far, perhaps beyond some "critical period," to reverse the behavior acquired in the feral environment.

In order to test the reverse, it was Kellogg's idea to take an ape and rear it in a *prosthetic environment*, a human environment. Relevant to this, he states: "The opinion seems to persist among certain contemporary psychologists that a sharp qualitative demarcation between the behavior of man on the one hand and the behavior of infrahumans including the anthropoid apes, on the other hand, is an established fact."<sup>9</sup>

At the time Kellogg proposed his study for humanizing the ape, it was hypothesized—even believed—that the anatomy and vocal mechanism of the ape was such that it did not preclude the possibility of human speech.<sup>10</sup> Although Kellogg and Kellogg<sup>11</sup> and Hayes and Hayes<sup>12</sup> have reported very limited success in human speech development in the chimpanzee (i.e., three to four words), for the most part the hypothesis is untenable today.

## PROSTHETIC TRAINING

### Phonologic Prosthesis: Mechanical Mode

Disease and injury may cause damage to the vocal, articulatory, or auditory system. Prosthetic devices have been developed to partially compensate for some such handicaps. A variety of types of artificial larynges have been developed for laryngectomees and hearing aids are helpful for many auditorily impaired individuals. Except for the very young, individuals have developed speech and language prior to the necessity for a prosthetic device. It is an established fact that even moderate auditory handicaps may severely impair the development of speech and language. However, there is little evidence with respect to phonologic problems, perhaps because in most cases language has developed prior to the trauma to the larynx. There is, however, at least one report of teaching speech and language to a child laryngectomized at 20 months of age (Peterson's, 1973).<sup>13</sup> The training goals were to teach esophageal sound production, articulation, and training in expressive language.

Although it was pointed out previously in this article that the chimpanzee was capable of producing human vocal responses, a review of the literature<sup>14</sup> suggests that the vocal apparatus of the chimpanzee differs from that of man to an extent that militates against the development of human speech (a phonologic deficiency). However, there appears to be sufficient evidence to substantiate the ability of the chimpanzee to learn to respond to human speech (receptive-auditory mode), i.e., complex auditory stimuli.<sup>15</sup> To this point the chimpanzee's handicap in language development (speech) appears to be phonologic in nature. The problem is then, how to circumvent the anatomical deficiencies associated with the production of human speech sounds. The chimpanzee has frequently been selected as the "drawing board" for the study of higher mental processes. This no doubt has resulted from the fact that the chimpanzee ranks high on the phylogenetic scale with respect to sociability and intellectual potentiality.<sup>16</sup>

Premack and Schwartz,<sup>17</sup> believing that the chimpanzee's major deficiency lay in the expressive (productive) area of speech, embarked on a project to develop a synthetic (mechanical) device capable of producing complex auditory

stimuli. Although this device would not require the chimpanzee to vocalize, it would require a complex set of motor movements to operate it and the ability to make complex auditory discriminations. Most importantly, this approach to the problem forced Premack and Schwartz to make a comprehensive review of language development, grammar, and syntax.

The study of the continuity problem between man and chimpanzee was continued by Premack and Schwartz in an experimental fashion. What they proposed to teach the chimpanzee was a sort of five-dimensional code in which the auditory dimensions were correlated with the motor dimensions. The production of auditory signals was to be controlled by a joy-stick apparatus with the sound produced by a device similar to an electric organ. It was proposed that the chimpanzee would be taught a phrase-structure grammar.

The most important question was, would this study teach us something about language development or would it result in just another failure to teach the chimpanzee to talk? Premack<sup>18</sup> subsequently stated that "not only human phonology but quite possibly human syntax may be unique to man." However, there was still an assumption that, irrespective of higher cortical functions (e.g., Pribram<sup>19</sup>), semantics which form the basis for language are present at the subhuman level. Therefore, Premack and Schwartz<sup>20</sup> decided to circumvent the larynx problem with a synthetic device that was capable of simulating vocalizations.

It is the authors' opinion that this multidimensional system is much too complex for the young child or ape. This system was eventually discarded, perhaps because of that complexity; however, there is perhaps good reason to use the chimpanzee as a "drawing board" for delineating strategies and tactics relevant to communication problems. Later in this article we will see that Premack was successful in establishing a continuity between human language and animal communication. For starters, with respect to language and speech, primates may be considered functionally limited—even with respect to the expressive aspects of speech and language development. In this regard we should be aware of the *fallacy of equating speech with language*.

### Phonologic and Auditory Prosthesis: Gestural Mode

Now, consider the chimpanzee as subject, another "drawing board." There is little doubt that the laboratory and home-reared chimpanzee still displays many of the characteristics of a wild animal.<sup>21</sup> However, chimpanzees are highly social animals and do respond differentially to social roles, even those played by a human.<sup>22</sup> Moreover, the chimpanzee finds manipulatory mechanical problems his forte and even laboratory chimps have been frequently observed to gesture spontaneously.<sup>23</sup>

Fingerspelling and the American Sign Language (ASL) are standardized systems for two-way communication for deaf or retarded children. Training a chimpanzee to use ASL would provide a linguistic environment analogous to that of a deaf child with deaf parents. In one situation, the Gardners undertook the task of training Washoe, a chimpanzee, to use ASL.<sup>24</sup> The strategy was to take advantage of two chim-

panzee characteristics: (1) the ability to make complex hand movements, and (2) the frequency with which chimpanzees have been observed to imitate human acts. The tactic for training was to provide an environment conducive to the development of chimpanzee-human social interactions, while applying shaping and operant conditioning techniques to develop sign language in the chimpanzee.

The Gardners maintained records on Washoe's daily signing behavior. By the 22nd training month of the experiment, they were able to list 30 signs that met their criterion; for example: come-gimme, up, open, drink, you, smell, clean, and hear-listen. The criterion for acquisition consisted of at least one appropriate and spontaneous occurrence each day over a period of 15 consecutive days. The results showed a median of 29 signs per day with a range of 23 to 28 different signs out of a total of 34 signs. Reliability consisted of the agreement between three observers that the sign was actually in Washoe's repertoire. The chimp's rate of acquisition for the 21-month period clearly indicates the phenomenon of "learning to learn" or "learning sets."<sup>25</sup>

The Gardners acknowledged a context problem and viewed it in terms of sign transfer, i.e., from a very specific referent in initial training to new members of each class of referents. Thus, after Washoe learned, in initial training, *open* for a specific door and *hat* for a specific hat, she was able to transfer her learnings spontaneously to new members of each class of referents. The Gardners cited several examples of this class of behavior.<sup>26</sup> For example, they pointed out in their discussion of key use (to open locks) that Washoe learned to ask for keys (emitted key sign) when no key was in sight. In addition, Washoe was observed to use signs (i.e., two or more signs) in strings apparently spontaneously (i.e., without specific stimuli). At this point we can pose the question, did Washoe develop a functional language? The results of the experiment show that Washoe demonstrated: (1) spontaneous naming; (2) spontaneous transfer to new referents; (3) spontaneous combinations and recombinations of signs. Fouts<sup>27</sup> has, in essence, replicated the Gardners' ASL study, using four young chimpanzees. Thus the learning of ASL in the chimpanzee population is not unique, and it can be concluded that Washoe was not an exceptional chimpanzee in her ability to acquire signs. This type of study also can apply to retarded-deaf children, as Berger<sup>28</sup> found in a clinical program using similar procedures.

#### **Phonologic and Auditory Prosthesis: Synthetic [plastic-word] Mode**

Up to this point, we have seen the contribution of linguistics, programming, and logic to teaching language to the chimpanzee and some application to the deficient child. The limiting factor for language development by the chimpanzee or language deficient child may not be language *per se*, but the complexity of the response, i.e., its topography. For example, as Carrier noted, the response mode most commonly associated with language is oral speech, which can be defined as various phonemic responses arranged to create morphemes—which, in turn, may be arranged to create grammatical utterances.<sup>29</sup> Three years ago, Premack<sup>30</sup> reversed his earlier experimental direction

and moved from the complex topography required by a mechanical device for phonologic prosthesis to a simple synthetic ("plastic word") system using abstract "words" on movable metal-backed plastic pieces. Again, Premack was asking the question, can the chimpanzee be taught language? The determiner of the answer to this question is "what is language?" First, Premack provided a list of exemplars, things the chimp (or child) must be able to do in order to demonstrate a functional language. Second, he stated a method of training must be provided so that the chimp can be taught the exemplars in question. For starters, Premack suggested the following exemplars: (1) words; (2) sentences; (3) questions; (4) metalinguistics (using language to teach language); (5) class concepts; (6) the copula (verb link); (7) quantifiers; and (8) the logical connective—e.g., "if-then." The word stimuli in this system are pieces of plastic backed with metal so that they will adhere to a magnetized slate. The plastic-words are abstract in configuration and are analogous to Chinese characters. The placing of the plastic-words on the slate requires only gross motor movements, a great simplification when compared to the complex motor behavior and auditory discriminations required for spoken and gestural communication. A second advantage derives from the fact that the sentence made by the chimp is permanent, thus circumventing the memory problem. Third, the experimenter can modulate the difficulty of any task by controlling the number and kinds of words available to the subject at a given time. It should be evident that the phonologic problem has been **prosthethized** and that the basic unit is the word.<sup>31</sup>

Using the plastic words, Sarah, Premack's chimpanzee, is now able to read and write more than 130 words. But more importantly, she has learned the following: (1) use of the interrogative; (2) metalinguistics; (3) class concepts; (4) use of simple and compound sentences; (5) pluralization; (6) quantifiers; (7) use of the logical connective—"if-then"; (8) and the conjunctive *and*. What Premack in fact has accomplished is to prove a functional analysis of language. This approach to analyzing and teaching language has reduced the cognitive parameters of language to discrete events that can be defined and manipulated. This strategy coupled with the tactic of a simple response topography provides a powerful technique for training communication deficient children.

#### **Teaching Language to the Severely Retarded**

It is a foregone conclusion that there is a significant relationship between language development and measured intelligence. The traditional intelligence tests contain both verbal and performance scales. It is the verbal scale (language) that proves most difficult for the retardate and places the severely retarded in the category of untestable in situations requiring language use. Are these children severely retarded (with respect to measured intelligence) because of failure to learn language or because of some yet undetected factor? It would appear that the interactions between language and non-language learning are so strong that it is doubtful that a child can make much progress in learning one without acquiring skills in the other (e.g., Kellogg and

Kellogg<sup>32</sup>). In an attempt to answer these questions, Carrier<sup>33</sup> has begun a replication of Premack's experiment with Sarah, using severely retarded children as subjects.

We first must accept the premise that the language system of a child's environment is a fact of life, and however inefficient it may be, is the one the child must learn. Thus, the process of determining program goals for children requires not only a consideration of language function, but also a consideration of semantics and syntax as they actually exist. In other words, the programmer must select from the corpus of acceptable linguistic responses, a set that will serve the communication needs of the child. Carrier<sup>34</sup> outlined a model for language development in the child<sup>35</sup>. Since it is quite complex, only a brief outline of the initial steps will be presented.

The first step in the development of this model was an attempt to define operationally two sets of rules and prin-

ciples, each of which is an integral part of language. One set of rules consists of those used for the selection of symbols to represent different meanings. In writing, the written symbol boy may be used to represent a young male human. Such rules and principles relate to what we may refer to as the semantic parameter of language. The other set of rules or principles, relating to what we call the syntactic parameter of language, consists of those which determine the sequential arrangement of symbols in a standard grammatical response. For example, in an active declarative sentence, the subject noun precedes the verb, articles precede nouns—the order of words is a constant as "standardized" through usage. In Carrier's analysis<sup>36</sup>, semantic and syntactic systems are treated separately, although each is certainly dependent on the other for ultimate linguistic performance. The purpose of the syntax parameter of the model was to define operations that would result in correctly arranged sequences of symbols.

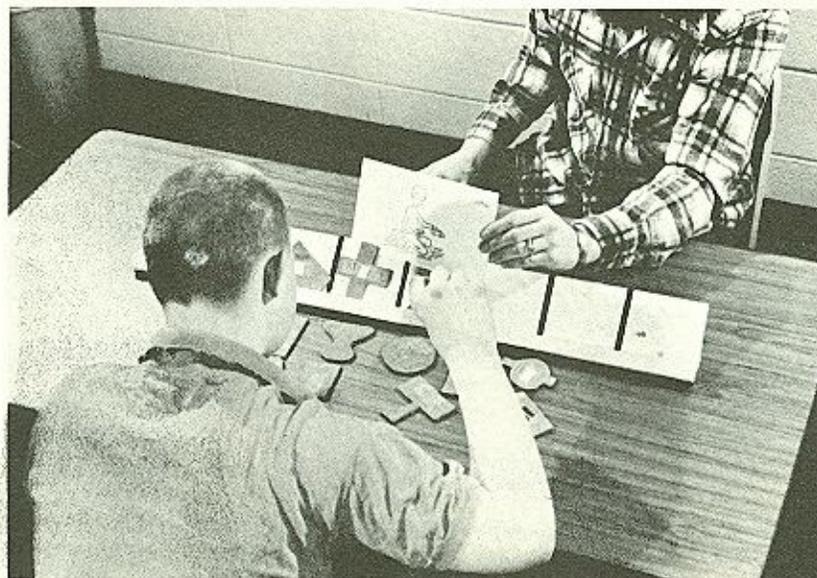
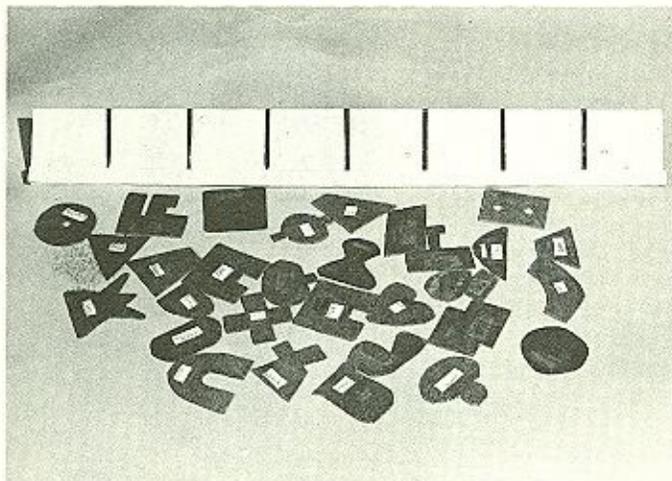
**Figure 1. Elizabeth (chimpanzee) writing a message to Debby. The message reads (top to bottom), "Give banana Elizabeth." Debby is about to give Elizabeth a piece of**

**banana. At this stage of training Elizabeth had learned 25 words. (Courtesy of David Premack, January, 1974).**



The function of the semantic model was to delineate operations necessary to appropriately select symbols. The semantic model, because there are many functionally determined classes of symbols, consists of several different parts. Each part defines the operations necessary for selecting a specific member from that class. The operations are nothing more than series of binary discriminations, performed in specific sequences.

Presently, data are available for 50 subjects who have gone through at least some part of the training sequence. These subjects are all institutionalized retardates classified as severely or profoundly retarded.<sup>37</sup> Many of the subjects do have mild sensory and/or motor involvement, but none is so impaired as to be physically unable to perform the required tasks. None of the subjects initially used speech for communicative purposes. The results, to date, may be summarized briefly as follows: (1) the acquisition of the first two verbs and prepositions is the most difficult; (2) session times required to learn various constituents become shorter and shorter as subjects progress through the programs; (3) the data suggest that semantic features of the symbols are becoming cues for syntactic sequences; (4) teaching ad-



ditional sentence structures becomes easier; (5) errors in advanced stages of the program resemble those in the grammar of speaking children; (6) the subjects become extremely proficient at constructing sentences, but as the number of alternative forms becomes large (e.g., 50-100), rate of response decreases and occasional errors occur.

#### **Prosthetic Implications for Retarded Children's Communication Deficiencies**

Of the methods presented in this article with regard to the prosthesis for communication deficiencies, Premack's systematic approach to teaching language appears to offer the most promise. Carrier<sup>38</sup> presents rather impressive evidence which substantiates this conclusion, even though his work is still in its early stages. Perhaps most significantly, Carrier has obtained conclusive evidence that when using Premack's non-speech-response mode, many severely and profoundly retarded children can and do learn at least parts of a communication system. The next step visualized would be to have two retardates communicating with each other over closed-circuit TV using plastic words. Certainly, this would demonstrate that this type of communication is a functional language within the peer-dyad and thus demonstrate its utility.

#### **Prosthesis for Intelligence?**

Children tend to improve steadily in their performance on intelligence tests until their late teens (which could be considered one indication of mental growth). In addition, it has been demonstrated that retarded children can with training improve their performance on intelligence tests. What, then, is intelligence? One succinct answer is Boring's: "Intelligence is what the tests test"<sup>39</sup> A relevant point frequently overlooked is that intelligence tests (e.g., Stanford Binet) are validated on academic classroom performance. Such tests do not measure a "common factor," but if we were to infer one, it would have to be the ability to use language. Until recently this was considered an ability ascribed only to

**Figure 2. Retarded child's response tray and word symbols. The symbols represent sentence units as follows: article, noun, aux. verb, and preposition.**

**Figure 3. A retarded child writing the sentence, "The boy is sitting on the floor." He has completed, "The boy is sit" and is in the process of placing "ing" on the tray.**

humans. However, the successes of the Gardners<sup>40</sup> and Premacks<sup>41</sup> in teaching language to chimpanzees no longer makes this a valid assumption.

Let us now consider the severely or profoundly retarded child with respect to the concept of intelligence. We have classified him as retarded on the basis of measured intelligence, knowing full well that the tests are heavily loaded with language. Furthermore, we have already pointed out that the interaction between language and non-language learning may be so strong that it is doubtful that a child can make much progress in learning one without acquiring skills in the other. Even a cursory overview of Premack's work would suggest that he is rapidly developing procedures for demonstrating the concepts underlying language. These concepts are independent of language and are developed through the natural contingencies provided by the physical environment, rather than through social contingencies as are applied to language. For example, Mason<sup>42</sup> has studied in detail the concepts developed by infant rhesus monkeys with respect to the physical characteristics of their mother surrogate, a nonsocial entity. It would appear that the mapping of existing environmental distinctions (one's stimulus surroundings) is a necessary prerequisite for the development of language.

For both the retardate and very young deaf it would appear that the prosthesis for intelligence may be a reality. That is, we now can surmount the language barrier by providing a non-speech response mode for communication. This eliminates the need for learning speech, or learning speech simultaneously with linguistic principles, and opens a whole new vista for teaching the language-deficient child.

#### FOOTNOTES

1. This article is a condensed version of Working Paper No. 298, Parsons Research Center, Parsons, Kansas. Selected parts of the original were presented at the 1973 meeting of the American Association on Mental Deficiency at Atlanta, Georgia. This paper in part was supported with funds provided under NICHD grant 00870-0.

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35. For additional information, write Dr. J.K. Carrier, Parsons Research Center, Parson, Kansas 67357.

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